TITLE OF THE INVENTION

USE OF A PRESELECTION FILTER BANK AND SWITCHED LOCAL OSCILLATOR COUNTER IN AN INSTRUMENTATION RECEIVER

BACKGROUND OF THE INVENTION

The present invention relates to spectrum analysis, and more particularly to an instrumentation receiver using a preselection filter bank and a switched local oscillator counter.

A known instrumentation receiver described in U.S. Patent No. 6,316,928 incorporates a yttrium-iron-garnet (YIG) tuned oscillator (YTO) as a sweep frequency local oscillator and a YIG tuned filter (YTF) as a frequency preselector for an incoming RF signal. The YTF is used to remove image products in a high frequency band before a first conversion stage. However the YTF has the disadvantages of high cost and limited bandwidth. The architecture disclosed in the '928 patent is a dual-IF architecture having a baseband IF channel and a high-band IF channel both using the same YTO. The baseband IF channel upconverts the RF signal to a first IF frequency, bandpass filters the first IF frequency and downconverts to a second IF frequency. The high-band IF channel preselects a frequency band using the YTF and downconverts directly to the second IF frequency. An input switch allows the RF signal to be processed by either the baseband or high-band IF channel, with a corresponding output switch selecting the selected IF channel for further processing. This architecture provides a two-octave bandwidth from a one-octave YTO rather than using a more expensive two-octave YTO.

What is desired is an instrumentation receiver that has a lower cost while providing a greater bandwidth.

BRIEF SUMMARY OF THE INVENTION

Accordingly the present invention provides an instrumentation receiver architecture for processing an RF signal that has a dual-IF channel architecture, a low-band IF channel and a high-band IF channel, that includes a bank of preselection filters at the input of the high-band IF channel to select a frequency band from the RF signal for processing by the high-band IF channel. A common tunable oscillator, such as an yttrium-iron-garnet (YIG) tunable oscillator (YTO), a voltage controlled oscillator (VCO), a bank of VCOs, or the like, is used to provide a different first stage mixing frequency range to both IF channels, the frequency range applied to the high-band IF channel generally being higher than that applied to the low-band channel. In a first implementation the low-band IF channel up-converts a lowpass filtered RF signal to an first IF signal and then down-converts the first IF signal to a second IF signal, while the high-band IF channel down converts the selected frequency band of the RF signal to the second IF signal. The output from the selected one of the IF channels is digitized for processing by a digital signal processor (DSP). In a second implementation the outputs from the first stage conversion in each IF channel, having different IF frequencies, are selectively input to a configurable down conversion stage which converts the outputs from the respective first stages to a common IF frequency for further processing. In a third implementation the low-band IF channel also contains a bank of preselection filters so that the input to the first stage is either the lowpass filtered RF signal or a selected frequency band from the RF signal, with the first stage acting as an up-converter when the input is the lowpass

filtered RF signal and as a down-converter when the input is the selected frequency band. The output from the first stages are input to the configurable down conversion stage as in the second implementation.

The objects, advantages and other novel features of the present invention are apparent from the following detailed description when read in conjunction with the appended claims and attached drawing.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Fig. 1 is a block diagram view of a first implementation of an instrument receiver architecture according to the present invention.

Fig. 2 is a block diagram view of a second implementation of an instrument receiver architecture according to the present invention.

Fig. 3 is a block diagram view of a third implementation of an instrument receiver architecture according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 1 an instrumentation receiver **10** receives an input signal and directs it via an input switch **12** to either a baseband (low frequency band) intermediate frequency (IF) channel **14** or a high frequency band IF channel **16**. At the input to the lo-band IF channel **14** is a lowpass filter **18**, the output of which is input to a first mixer stage **20**. A YIG tuned oscillator (YTO) **22** having a tunable frequency output is input to a counter/divider **24**, which for this example is a divide-by-two counter although generally any integer divisor may be used. The particular divisor used is a

function of the relationship between the low frequency band IF and the high frequency band IF. The output from the counter/divider **24** is input to the first mixer stage **20**, the output of which is a first intermediate frequency (IF_1) signal up converted from the input signal. A first bandpass filter **26** acts as an anti-aliasing filter for the IF_1 signal which is then input to a second mixing stage **28** having a voltage controlled oscillator (VCO) **30** to produce a down converted second intermediate frequency (IF_2) signal.

A local oscillator switch **32** couples the output from the YTO **22** to either the counter/divider **24** or directly to a hi-band mixer stage **34** in the hi-band IF channel **16**. At the input to the hi-band IF channel **16** is a bank of preselection, bandpass filters **36** which select a particular frequency pass band from the input signal for input to the hi-band mixer stage **34**. The filter in the filter bank **36** chosen depends on the frequency of the energy in the input signal to be measured. Each filter is designed such that it cuts off energy at the image frequencies for that band and rejects local oscillator power from leaking at the input. The hi-band mixer stage **34** acts as a down converter to provide an output signal at the IF_2 frequency so that the output signals from both the hi-band and lo-band IF channels **14, 16** are at the same IF. The outputs from the hi-band and lo-band IF channels **14, 16** are input to a second bandpass, anti-aliasing filter **38** via an output switch **40**. Further down conversion is achieved in a third mixing stage **42** with its own VCO **44** to provide a third IF signal (IF_3) which is input to a third bandpass, anti-aliasing filter **46**. This further down conversion may or may not be necessary, depending upon the capabilities of an analog-to-digital converter (ADC) **48**,

which ADC digitizes the output from the selected IF channel **14, 16** for further processing by a digital signal processor (DSP) (not shown). The IF detection need not be done with an ADC by using a more traditional approach using a logarithmic amplifier and a diode detector. As shown, the hi-band IF channel **16** uses the YTO **22** output directly, while the lo-band IF channel **14** uses a modified frequency range output from the YTO using the counter/divider **24**.

In operation one of the lo-band or hi-band IF channels **14, 16** is selected by the input switch **12** to receive a desired frequency range, i.e., 0-M GHz or M-N Ghz respectively. The YTO **22** frequency sweep range is determined by DSP according to the IF channel selected. The low range is up converted in the lo-band IF channel **14** and then down converted, as described above, to obtain IF_2. The high range is down converted in the hi-band IF channel **16** to obtain IF_2, as described above, with the YTO **22** frequency sweep range being determined by the particular filter in the filter bank **36** that is selected, i.e., according to the particular frequency band in the high range selected for processing.

An alternative embodiment is shown in Fig. 2 where the output from the hi-band IF channel **16** is a first hi-band IF signal IF_1'. This signal is input to an anti-aliasing, bandpass filter **50**, the output of which is input to the channel selection switch **40'**. The other input to the channel selection switch **40'** is the IF_1 from the lo-band IF channel **14**. In this case the second stage mixer **28'** has a selectable frequency as an input for mixing with the input IF signal. The mixer oscillator **30'** is switched by a frequency select switch **52** to be either directly input to the mixer **28'** or input via a divide-by-N circuit **54**. In

either event the output from the second stage mixer **28'** is the IF_2 signal. In other words the hi-band IF mixing stage **34** output is run in parallel with the lo-band first mixing stage **20** output, with the selection switch **40'** being before the second mixing stage **28'**. The IF frequencies are chosen such that the mixer oscillator **30'** may be divided by an integer "N" to select either the IF_1' signal from the hi-band IF channel **16** or the IF_1 signal from the lo-band first mixing stage **20** to produce the IF_2 signal. The advantage of this alternative is that the hi-band mixing stage **34** may be placed at a higher frequency than the embodiment of Fig. 1, thereby easing the preselection filter rejection requirements of the filter bank **36** as the image frequencies are farther away.

A further refinement of the alternative shown in Fig. 2 is shown in Fig. 3 where at the input to the lo-band IF channel **14** is a selection switch **56** which applies the input signal either to the lowpass filter **18** or to another preselection bank of bandpass filters **58**. This extends the first mixing stage **20'** up in frequency through the use of it's own preselector filter band switch **56**. If the filter bank **58** is not selected, then the input signal proceeds through the lo-band channel **14** as in Fig. 2 via a lo-band selector switch **60**. If the filter bank **58** is selected, then the signal is down converted by the mixer **20'** by passing through in the opposite direction, with the YTO **22** being retuned accordingly, to produce an IF_1' signal which is filtered by the lowpass filter **18** and input via the lo-band selection switch **60** to the IF_1' bandpass filter **50**. The IF1' signal is then processed as in Fig. 2.

In operation the embodiments in Figs. 2 and 3 act as described above with respect to Fig. 1, except the IF frequency at the output switch **40'**

depends upon the particular IF channel **14, 16** selected by the input switch **12**. In each instance the frequency range of the YTO **22** is determined by the particular channel and frequency band within the channel that is selected. The YTO sweep frequency range may be above or below the frequency range of the frequency band selected for processing in order to achieve the desired IF frequency, but the DSP makes the appropriate corrections to the data from the ADC **48** to compensate for any inversions. For example, the embodiment of Fig. 3 has been designed to cover a frequency from D.C. to at least 14 GHz, the lo-band IF channel **14** covering 0-8 GHz, with 0-3 GHz being up converted as in Fig. 1 and 3-8 GHz being down converted, and the hi-band IF channel **16** covering 8-14 GHz. For this implementation the YTO frequency sweep range is 9-15.5 GHz, which is less than one octave.

Although the three embodiments described use a YTO as the first local oscillator, other types of tunable oscillators may be used, such as a voltage controlled oscillator (VCO), a bank of VCOs and the like.

Thus the present invention provides a dual IF processing architecture for an instrument receiver having a lo-band IF channel and a hi-band IF channel with a bank of preselection filters in the hi-band IF channel plus optionally another bank of preselection filters in the lo-band IF channel.